

# Residential home heating: The potential for air source heat pump technologies as an alternative to solid and liquid fuels



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## HIGHLIGHTS

- Air Source Heat Pumps can offer substantial savings over oil fired central heating.
- Significant residential air and climate emission reductions are possible.
- Associated health and environmental benefits are estimated up to €100m per annum.
- Results can inform policy interventions in the residential market to support change.

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## ABSTRACT

International commitments on greenhouse gases, renewables and air quality warrant consideration of alternative residential heating technologies. The residential sector in Ireland accounts for approximately 25% of primary energy demand with roughly half of primary home heating fuelled by oil and 11% by solid fuels. Displacing oil and solid fuel usage with air source heat pump (ASHP) technology could offer household cost savings, reductions in emissions, and reduced health impacts. An economic analysis estimates that 60% of homes using oil, have the potential to deliver savings in the region of €600 per annum when considering both running and annualised capital costs. Scenario analysis estimates that a grant of €2400 could increase the potential market uptake of oil users by up to 17% points, whilst a higher oil price, similar to 2013, could further increase uptake from heating oil users by 24% points. Under a combined oil-price and grant scenario, CO<sub>2</sub> emissions reduce by over 4 million tonnes per annum and residential PM<sub>2.5</sub> and NO<sub>x</sub> emissions from oil and peat reduce close to zero. Corresponding health and environmental benefits are estimated in the region of €100m per annum. Sensitivity analyses are presented assessing the impact of alternate discount rates and technology performance. This research confirms the potential for ASHP technology and identifies and informs policy design considerations with regard to oil price trends, access to capital, targeting of grants, and addressing transactions costs.

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## 1. Introduction

Residential energy demand, and the associated choice of fuels and technologies, has implications for both greenhouse gases and emissions of particulate matter and other air pollutants. National and international commitments on greenhouse gases, renewables and air quality warrant greater consideration of alternative residential heating technologies. The residential market for final energy consumption accounted for 27% of final energy demand across all sectors in the EU28<sup>1</sup> in 2013. The scale of the residential energy

demand market, as well as the number of individual agents involved, establishes it as an important and challenging sector to manage in respect of international environmental and energy policy.

Household energy demand is principally made up of energy requirements for space and water heating, as well as energy for appliances. The 2013 distribution of EU28 final energy consumption in households by fuel is shown in Fig. 1. Clearly fossil fuels continue to play a significant role in residential energy use. Research by Connolly et al. (2013) estimated that for the EU27 in 2010, the fuel type for almost three quarters of the total heat supply to residential and service sector buildings was comprised of natural gas (44%), petroleum products (17%), combustible renewables (10%) and coal products (3%). However, at an individual country level there can be substantial variation in the residential fuel mix.

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<sup>1</sup> Eurostat Online Data Code TSDPC320 – (Accessed 7th March 2016).

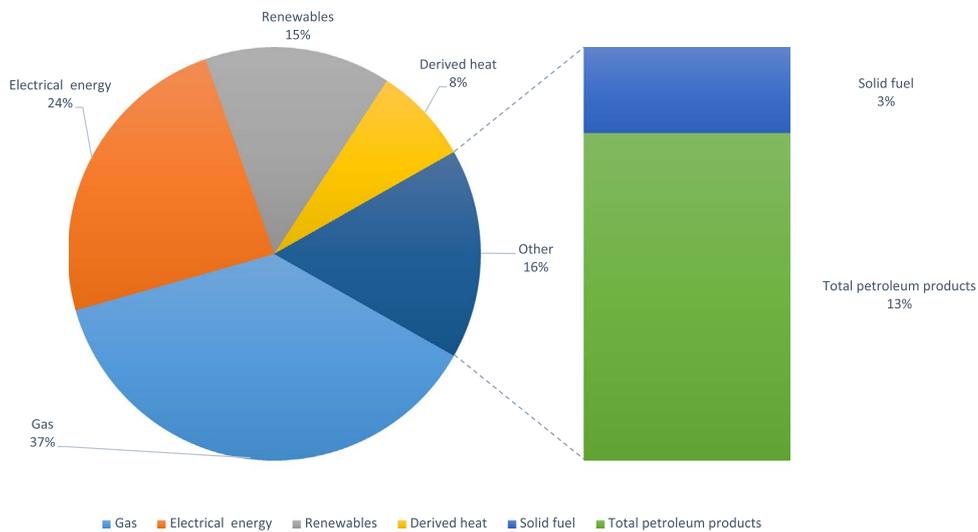


Fig. 1. EU 28 Final energy consumption in households by fuel in 2013. Source: Eurostat Online Data Code t2020\_rk10.

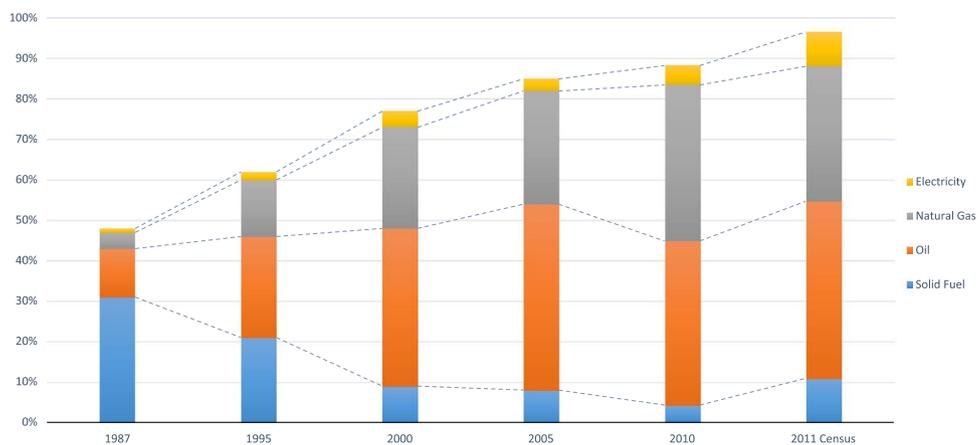


Fig. 2. Evolution of central heating by fuel type in Ireland from HBS surveys and census. Source: SEAI (2013) and CSO data.

Within Ireland there has been an interesting evolution of fuel choices in the residential sector over recent years as represented in Fig. 2. Historically, data on residential heating in Ireland has been gathered through a household budget survey,<sup>2</sup> which indicated a sharply falling trend in solid fuel use between 1987 and 2010, with the share dropping from 31–4.3%. Over the same period, the survey reported that the shares of oil fired and gas fired central heating grew substantially to 40.6% and 38.6% respectively. However, data from the Central Statistics Office Census of 2011 offers greater clarity on the nationwide statistics for residential heating, and suggests solid fuel was used by over 10% of households as their primary central heating fuel, with oil fired systems holding the largest market share at 43.8%.

Whilst specific fuel characteristics, combustion methods and technological factors will influence emission outcomes for the residential sector, data shown in Table 1 from the EMEP/EEA emission inventory guidebook 2013 show that solid fuel combustion at a household level will generally deliver substantially higher emissions of particulates and NO<sub>x</sub> than oil or gas fired systems. These emissions are harmful to human health, and create challenges in relation to European air quality legislation, which is now

Table 1

Tier 1 residential combustion PM<sub>2.5</sub> and NO<sub>x</sub> emission factors. Source: EMEP/EEA Emission Inventory Guidebook 2013 – Section 3.2.2.1 Residential Combustion (1. A.4.b).

Fuel type	PM <sub>2.5</sub> g/GJ	NO <sub>x</sub> g/GJ
Coals (including hard and brown coal)	398	110
Gaseous Fuels (including natural gas)	1.2	51
'Other' Liquid Fuels (including oil)	1.9	51
Biomass	740	80

driven by a focus on the reduction of negative health impacts (EC, 2013). Whilst electrified heating solutions generate no residential emissions at point of use, it is acknowledged that they may, of course, contribute to indirect emissions dependent on the source of electricity generation and the coefficient of performance (COP) of the electrified technology.<sup>3</sup> Nonetheless, there is an important distinction between the effects of household-level combustion of fuels, which emit pollutants at a low elevation often within more populated residential areas, and the effects of combustion in a

<sup>3</sup> The coefficient of performance in this context refers to the ratio of heating from a technology to the amount electrical energy utilised. The higher the COP the lower the operating cost.

<sup>2</sup> <http://www.cso.ie/en/statistics/housingandhouseholds/> (accessed 7th March 2016).

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